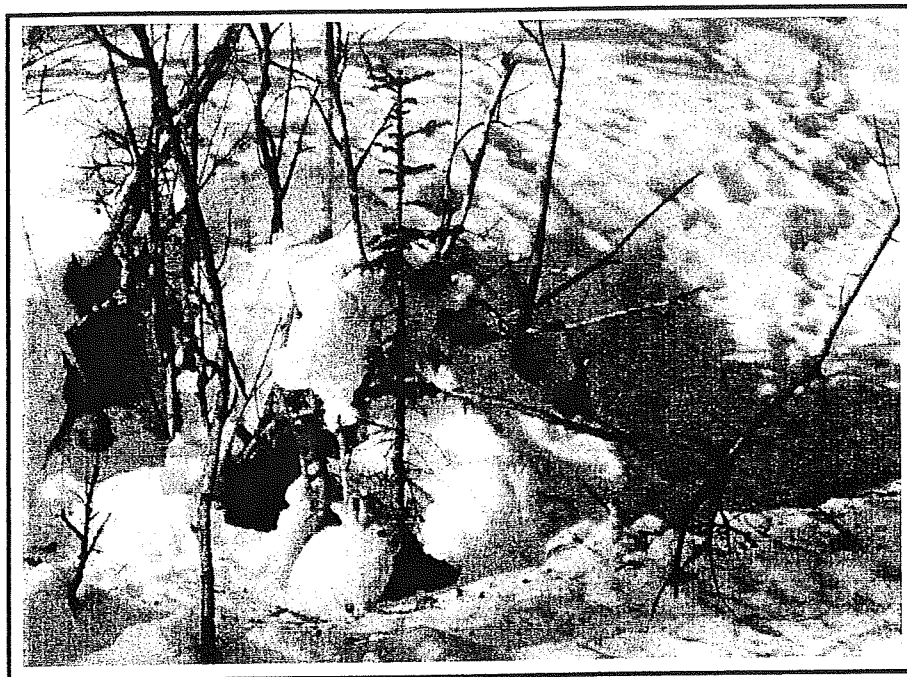


**SNOWSHOE HARE ABUNDANCE IN THE WISEMAN AREA OF  
GATES OF THE ARCTIC NATIONAL PARK AND PRESERVE, ALASKA**  
Fourth Annual Study and Summary Report



GAAR-00-04  
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## INTRODUCTION

In March 1997, resource personnel at Gates of the Arctic National Park and Preserve (GAAR) began a long-term monitoring program of the snowshoe hare (*Lepus americanus*) population in the eastern portion of the park (DiFolco 1997). This project was developed in response to a 5-year furbearer study that discovered unusual sex and age ratios in the lynx (*Lynx canadensis*) population in this area, possibly the result of food stress (Swanson 1994). The close association between lynx and their primary prey, snowshoe hares, has been well documented (Elton and Nicholson 1942, Brand et al. 1976, Brand and Keith 1979). Area residents regularly trap lynx for subsistence purposes; thus, park managers hope to gain a better understanding of the health of the lynx population by monitoring their primary prey, snowshoe hares, as well as continuing to collect information from local trappers. The snowshoe hare project plans to track the hare population through a complete cycle as the population grows from low numbers to a peak and then crashes to low levels again. The purpose of the study is to provide managers with an index of the snowshoe hare population at each stage of this cycle.

This report documents the fourth year of the snowshoe hare study, and the third year during which browse data was collected. Since conditions for counting tracks seemed particularly difficult this year, more emphasis was placed on collecting additional browse data. Comparisons are made between the diameter at point of browse data collected in the past 3 years.

This year, many thanks go to Michelle and Jesse Reakoff, who provided excellent, reliable assistance in counting tracks, measuring browsed stems, and running snowmachines. Also, to my husband, Denny, who babysat all day for a week so I could run this survey.

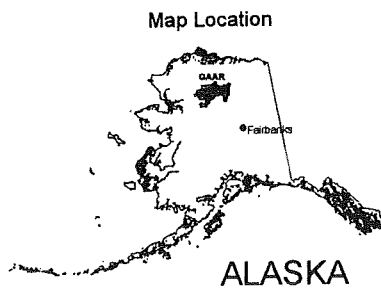
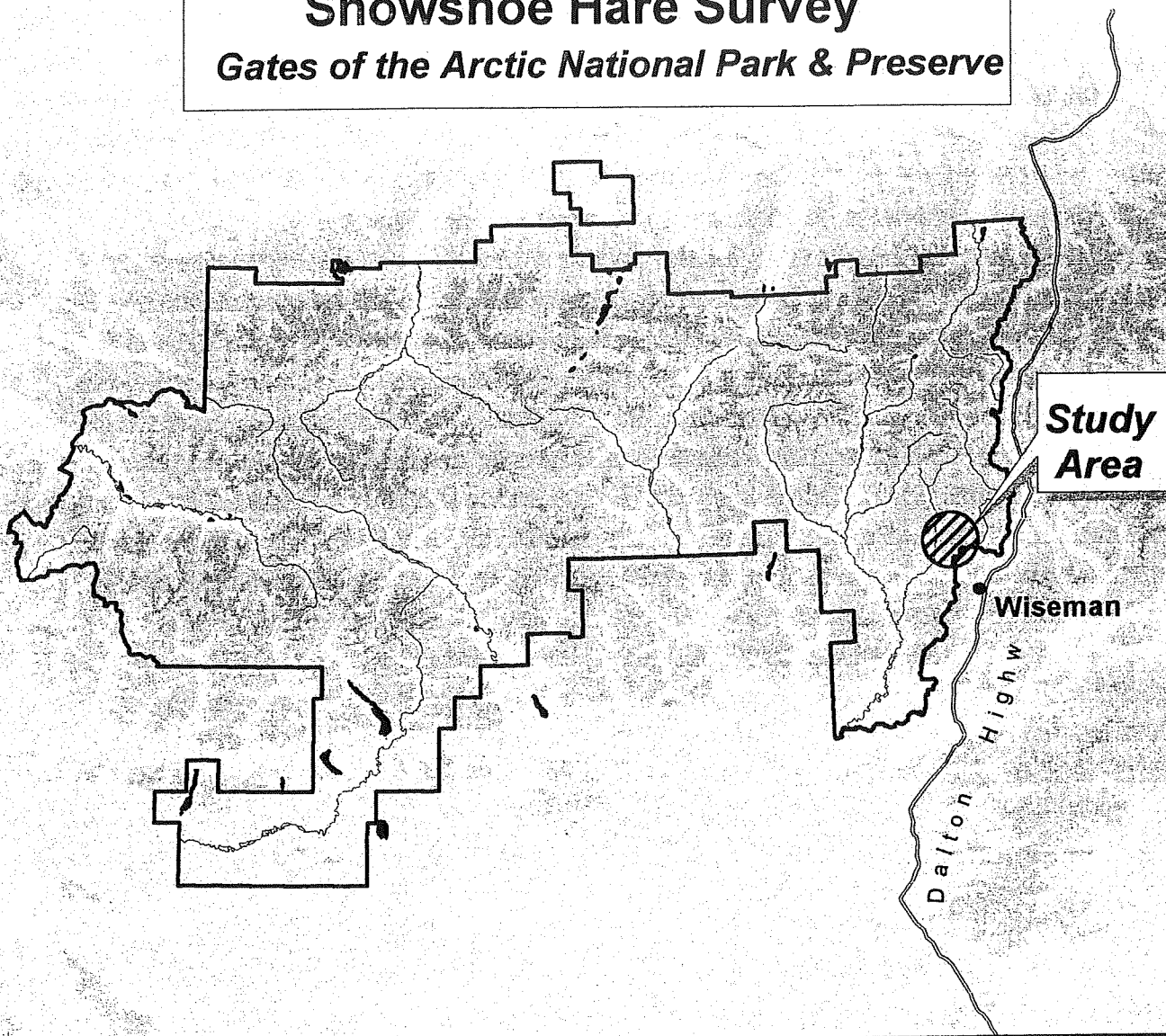
## STUDY AREA

Gates of the Arctic National Park and Preserve is located north of the Arctic Circle (66° 33' N latitude) in the central Brooks Range, Alaska (Fig. 1). Two climate zones occur in the park and preserve: the subarctic zone at lower elevations south of the continental divide and the arctic zone to the north and at high elevations. Precipitation is low within the park and preserve and yearly averages fall between 30 - 45 cm in the west and 13 - 25 cm in the north (National Park Service 1986). Snowfall averages south of the divide range between 152 - 203 cm and averages of 89 - 127 cm are typical in the north. Yearly temperatures in the south fluctuate from an average July maximum of 21° C (70° F) to an average January minimum of -34° C (-30° F). Temperatures in the north fluctuate from an average July maximum of 18° C (65° F) to an average February minimum of -23° C (-10° F).

Boreal forest, tundra, and shrub thicket are the major vegetation communities in the park and preserve (National Park Service 1986). The snowshoe hare study area lies in the boreal forest, which covers the southern flanks and valleys of the Brooks Range and is composed of black spruce (*Picea mariana*), white spruce (*P. glauca*), paper birch (*Betula papyrifera*), shrub

# Snowshoe Hare Survey

## *Gates of the Arctic National Park & Preserve*



25 0 25 Miles



Fig. 1. Study area for snowshoe hare survey near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve, March 2000.

birch (*B. glandulosa*), aspen (*Populus tremuloides*), and balsam poplar (*P. balsamifera*). Willow (*Salix* spp.) and alder (*Alnus* spp.) thickets up to 3.5 m in height occur along stream channels and gravel bars. The study was conducted near the eastern park boundary north of Wiseman (Fig. 1).

## METHODS

### Field Methods:

The 2000 study was conducted March 11-18, using the same methods as in the 1998 survey (DiFolco 1998, Golden 1994). Since the Nolan road was not plowed this year, we used snowmachines to drive from Wiseman to the study area. The eleven 100m transects established in 1998 in 6 different vegetation cover and composition classes (VCCs)—4 in lightly vegetated areas, 4 in moderately vegetated areas, and 3 in densely vegetated areas—were relocated using a Precision Lightweight GPS Receiver (PLGR) (Fig 2). Track deposition and retention were counted on 6 consecutive days. Tracks were brushed out on the deposition side of the transect following each day's count using leaf rakes. The retention side of the trail was brushed after the third day, and a new set of retention counts began on the fourth day. A "track" was defined as a single pass by one hare. Generally, up to 3 tracks could be distinguished when hares had passed over the same place. When more than 3 tracks had been deposited in the same place, it was called a "trail" since the number of tracks could no longer be determined. For track calculation purposes, a trail was conservatively approximated to equal 4 tracks.

Browse data also was collected. In addition to measuring diameter at point of browse (dpb, which was also collected in 1998 and 1999), we tallied degree of browsing by hares for each browsed species within each VCC. The degree of browsing was divided into the following 5 categories: 1) stem clipped and completely girdled; 2) stem clipped and mostly girdled (>50%, and <100%); 3) stem clipped and partly girdled (up to 50%); 4) stem clipped only; and 5) stem not browsed by hares. "Clipped" means the hare had cut completely through the stem, whereas "girdled" means the hare had chewed bark off the stem. "Completely girdled" means the hare had chewed the bark off all the way around the stem. Whereas dpb measurements were taken only from stems clipped during the current winter (consistent with the method used to measure dpb in 1998 and 1999), degree of browsing was tallied using all stems above snow level, regardless of age or whether it had been browsed recently, in previous years or not at all. This gave us a better picture of what was available, and how much of it had already been consumed by hares.

In 1998 and 1999, soil samples were collected from sites where hares consistently visited to consume the soils (DiFolco 1998, DiFolco 1999). These were analyzed for 5 mineral salts (calcium, chlorine, magnesium, potassium and sodium). This year, to determine which mineral(s) hares may be craving in the soil, we collected samples from 2 exposed soil banks along Marion Creek where hares could easily access the soils, but were *not* visiting these sites (Fig. 3). The

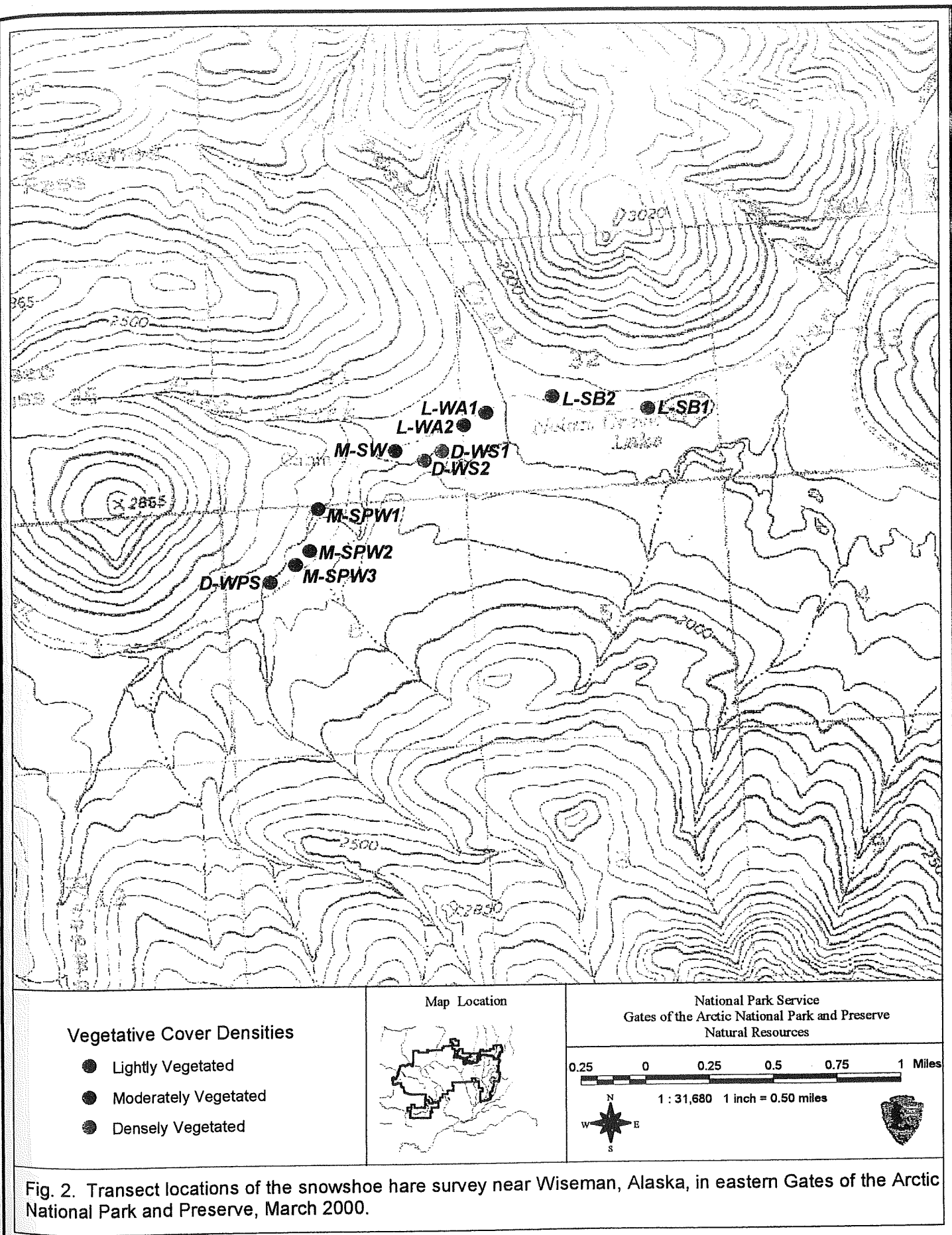


Fig. 2. Transect locations of the snowshoe hare survey near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve, March 2000.

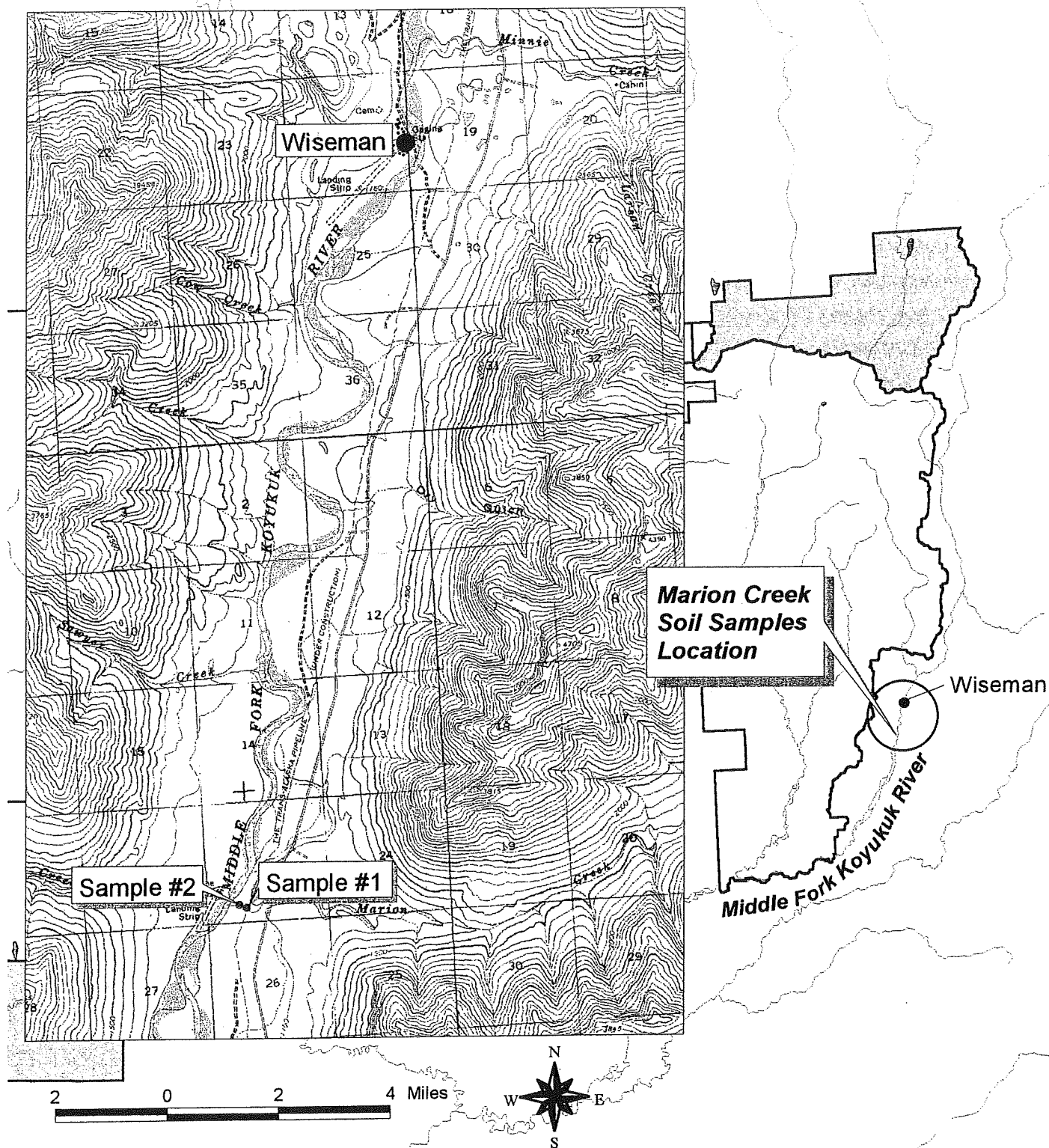


Fig. 3. Location of Marion Creek soil samples, snowshoe hare survey near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve, March 2000. Exposed soils at these sites were not visited by hares.

soil samples were collected with a clean metal spoon from the surface and stored in plastic ziplock bags until being tested at Northern Testing Laboratories, Inc., Fairbanks, Alaska, for the same mineral salts.

#### Statistical Methods:

Track deposition and retention data were entered into an Excel 97 spreadsheet. The mean, standard deviation, and 95% confidence interval around the mean were calculated for each set of transect deposition data. Dpb and degree of browse data were entered into Access 97 databases. The mean dpb was calculated for each species within each VCC and compared with the corresponding means of dpb from the previous 2 years.

## RESULTS

For brevity, acronyms are used to describe the vegetation cover and composition types (VCCs). The first letter describes the cover classification: L = lightly vegetated, M = moderately vegetated, and D = densely vegetated. Main species composition is listed after the hyphen (in order of relative abundance): W = willows, P = poplars, S = spruce, B = shrub birch, and A = alder.

#### Weather and Track Deposition and Retention

Weather during the survey was typically cool (below freezing), calm to light wind and no precipitation (Appendix III). No fresh snow fell before or during the count period, which would have greatly improved the survey's accuracy. The lack of freshly fallen snow, combined with high winds preceding the survey, caused poor tracking conditions. Once the snow had been "worked" by being trampled by hares and then brushed with a rake, the surface became very hard, making fresh hare tracks virtually invisible. Ideal conditions for counting tracks would be for about 5 cm of snow to fall 12 – 24 hours before the count began (Golden 1994).

Track deposition ranged from <2 tracks/100m in lightly vegetated areas, 10-25 tracks/100m in moderately vegetated areas, and 23-32 tracks/100m in densely vegetated areas (Fig. 4; Appendix I). Only 1 trail each in M-SPW and D-WPS was seen throughout the survey period.

In general, the number of tracks counted increased throughout the 3-day retention period, although in some cases, the number of tracks remained the same or even decreased from one day to the next. A decrease in the number of tracks could be due to changing snow conditions (e.g. sublimation, blowing snow, etc.), flat light conditions, or observer error. Figs. 5-10 show the results of both 3-day sets of retention counts; Appendix II lists all retention data. In the 4 lightly vegetated transects, there were 4-23 tracks and 0-3 trails counted at the end of the first count

# Deposition of Tracks Snowshoe Hare Survey 2000

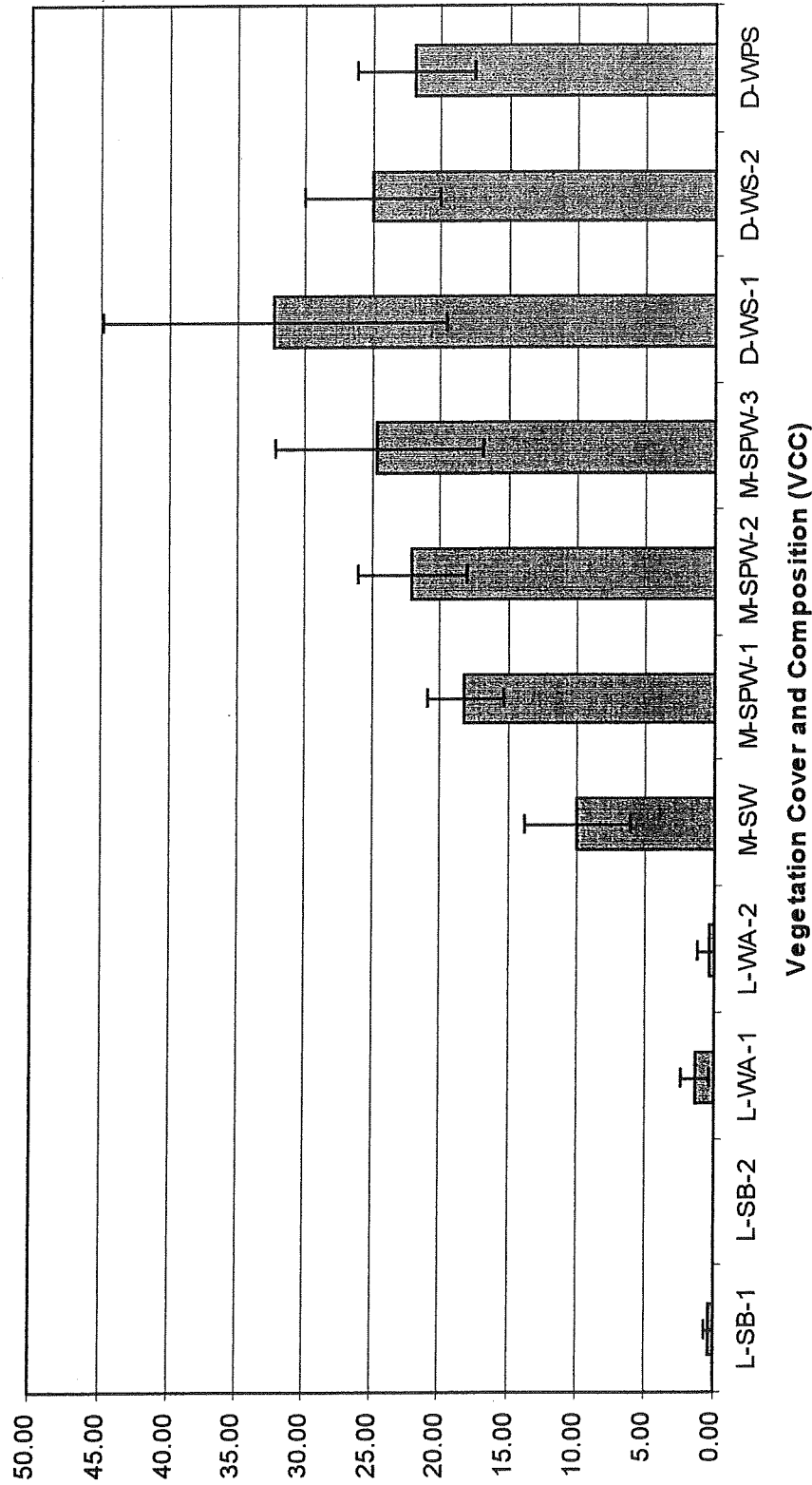


Fig. 4. Deposition of snowshoe hare tracks on 11 transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska. VCC codes are as follows: L, M and D = lightly, moderately and densely vegetated cover, respectively;

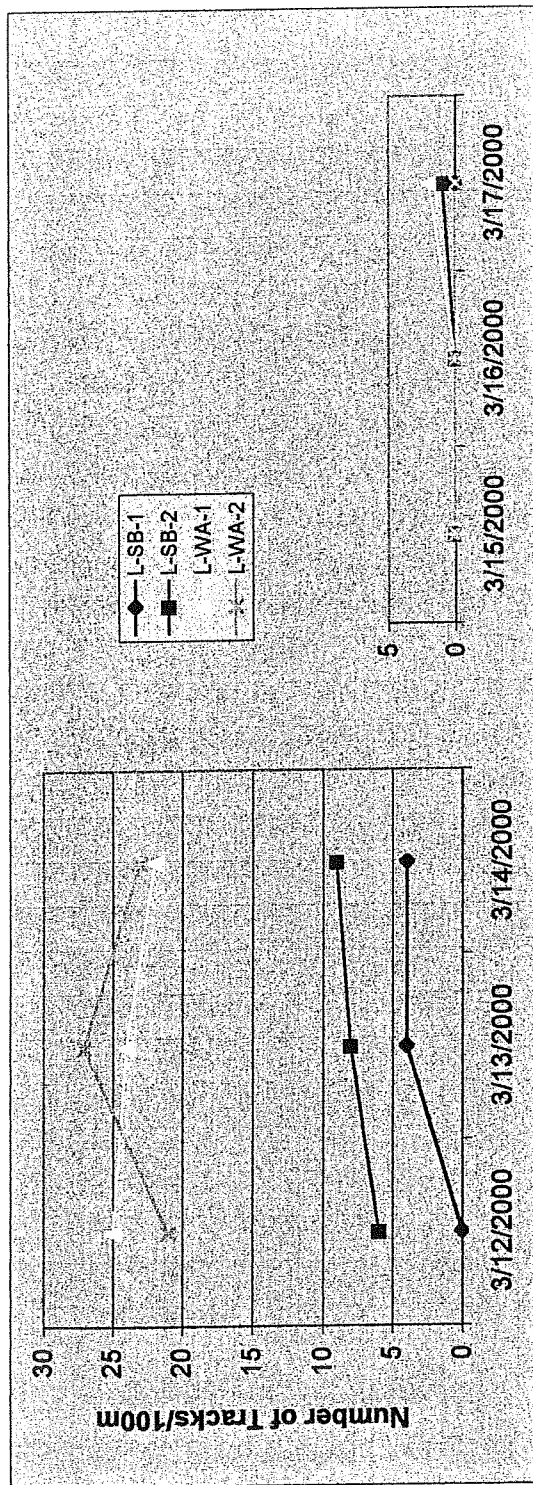


Fig. 5. Retention of snowshoe hare tracks in lightly vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska.

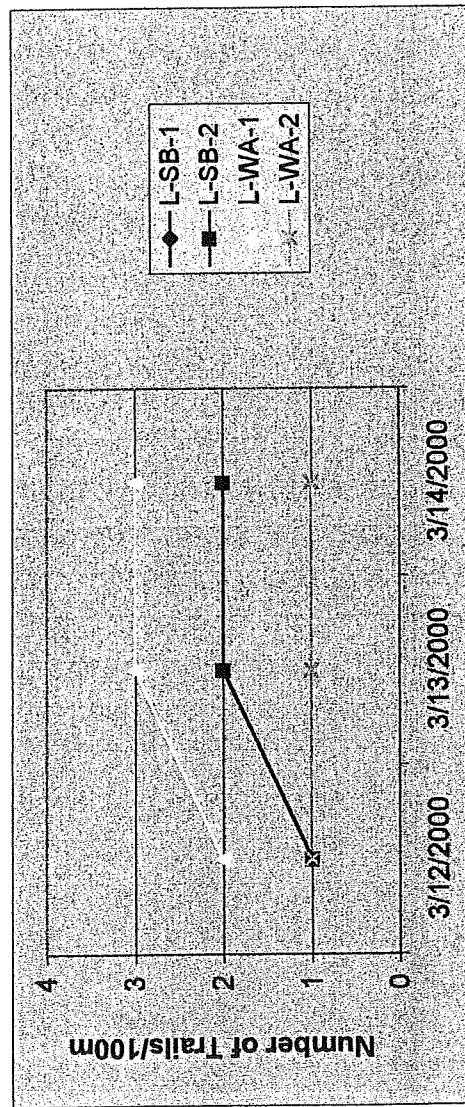


Fig. 6. Retention of snowshoe hare trails in lightly vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska. No trails were formed on these transects 3/15 - 3/17.

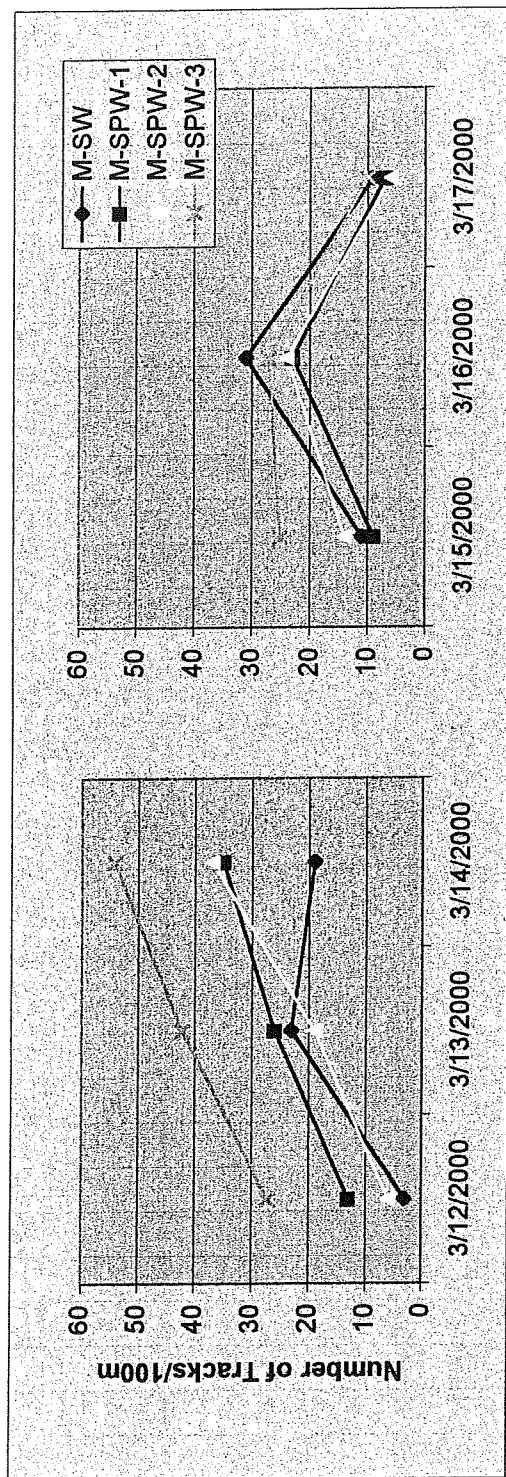


Fig. 7. Retention of snowshoe hare tracks in moderately vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska.

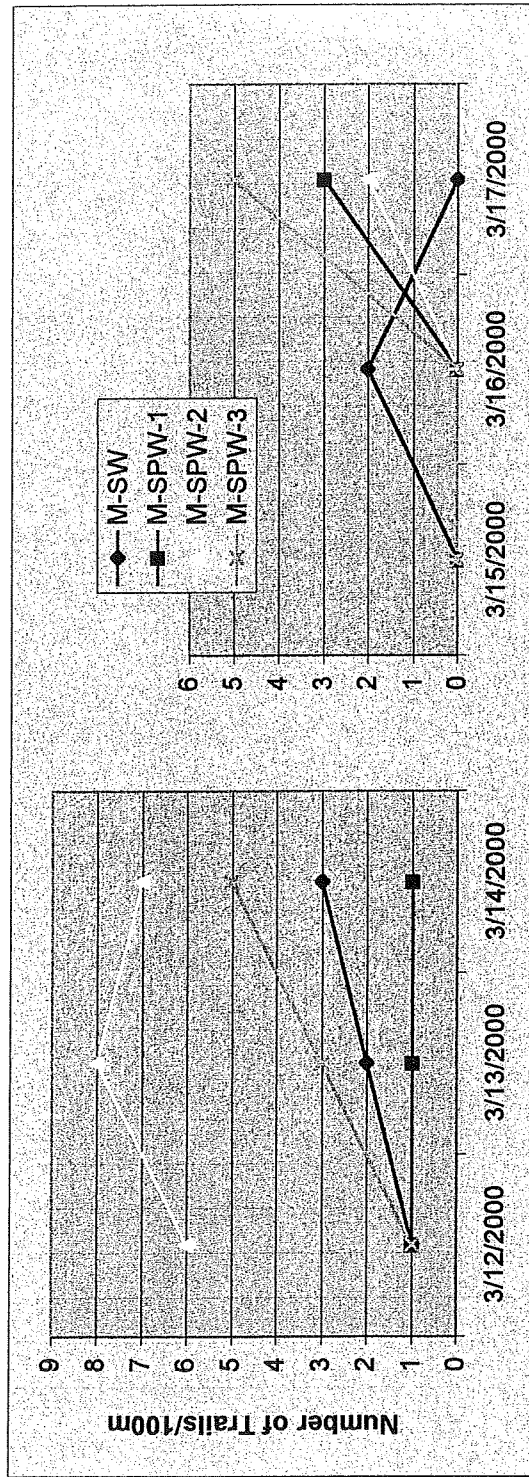


Fig. 8. Retention of snowshoe hare trails in moderately vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska.

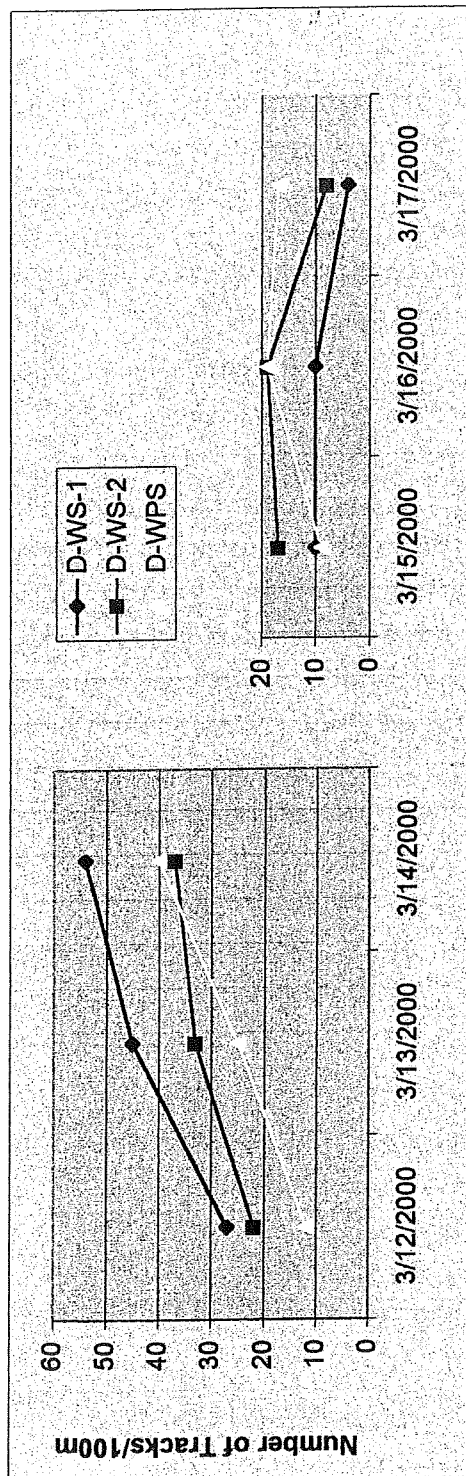


Fig. 9. Retention of snowshoe hare tracks in densely vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska.

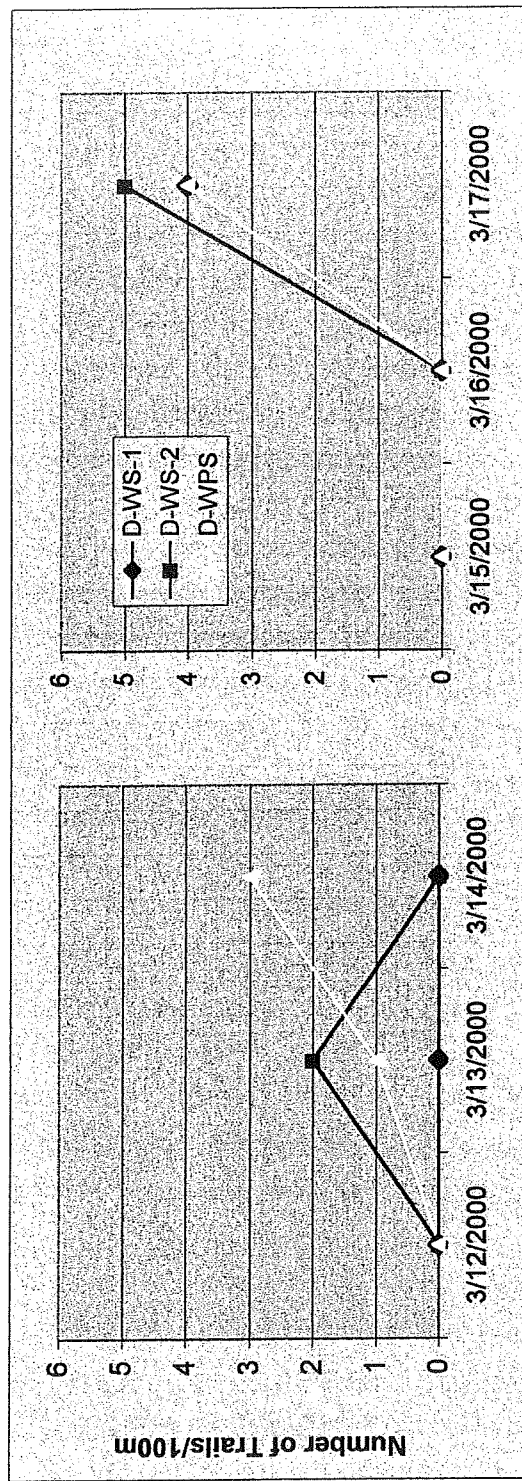


Fig. 10. Retention of snowshoe hare trails in densely vegetated transects, snowshoe hare survey, March 2000, Gates of the Arctic National Park and Preserve, Alaska.

period (March 12-14), and 0-2 tracks (no trails) counted at the end of the second count period (March 15-17) (Figs. 5 and 6; Appendix II). The relatively high numbers during the first count period may be due to counting old tracks that were not brushed out before the survey start. In the 4 moderately vegetated transects, 19-54 tracks and 1-7 trails were retained after the first 3 days; 6-10 tracks and 0-5 trails were retained after the next 3 days (Figs. 7 and 8; Appendix II). In the 3 densely vegetated transects, 37-54 tracks and 0-3 trails were counted on the third day; 4-17 tracks and 4-5 trails were counted on the last day (Figs. 9 and 10; Appendix II).

### Browsed Vegetation

Browsing by hares was obvious on most species (including willow, balsam poplar, spruce, alder and shrub birch) within every vegetation type. Dpb data were collected for the third year during this study (Table 1); results from 1998-2000 are summarized below and in Figs. 11-15. In addition to dpb measurements, a tally of browsed species within each VCC revealed that hares had browsed roughly 70% of all species, at least in some degree (Figs. 16-21).

#### *Diameter at Point of Browse:*

**Willows**—Salix spp. were browsed in all 6 vegetation types found along the survey route. The average diameter at point of browse (dpb) ranged from 4.2mm in L-SB to 8.8mm in D-WS. The smallest browsed willow stem measured 2mm (in L-SB and M-SW) whereas the largest measured 17mm (in D-WS). With the exception of M-SW, the dpb among willows in all VCCs was found to be larger in 2000 than in 1998 (Fig. 11).

**Balsam Poplar**—Average dpb of Populus balsamifera ranged from 5.0mm in L-WA to 6.9mm in M-SPW. Measurements of browsed stems ranged from 2mm (in D-WS) to 11mm (in M-SPW). In many areas, hares had already severely browsed the younger poplars, leaving only the larger trees with thick bark at the base and no small branches. Since 1998, the average dpb of poplars browsed by hares has slightly increased (Fig. 12).

**White Spruce**—Picea glauca were browsed in all vegetation types. In some areas, hares had chewed the bark off of the lower branches of larger trees. Spruce stems 1-5mm dpb, with an average dpb of 2.9mm were browsed in L-SB, while browsed spruce stems in D-WS and M-SW averaged 4.8mm dpb, with stem diameter ranging from 2.5-8mm. While hares have seemingly browsed smaller spruce stems in M-SPW since 1998, (from 6mm to less than 4mm in 2000), the dpb of spruce in D-WS, D-WPS and M-SW has increased over the last 3 years. In addition, measurements of dpb were obtained from spruce in L-SB and L-WA in the 2000 survey, whereas browsing of spruce had not been observed in these VCCs previously (Fig. 13).

**Shrub Birch**—Most of the Betula glandulosa was buried under deep snow this year, but were browsed where available in 2 of the VCCs (L-SB and L-WA). Dpb averaged 1.7mm in L-SB

Table 1. Browse data collected from 6 vegetation cover and composition (VCC) classes along the snowshoe hare survey transect, near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve, 11-17 March 2000. In VCCs, the letters stand for the following: L=light vegetation, M=moderate vegetation, D=dense vegetation, W=Willow sp., P=poplars, S=spruce, B=shrub birch, A=alder. DPB=diameter at point of browse.

SPECIES	VCC	Avg DPB	Min	Max	Count
ALDER	L-WA	5.93	2	10	15
SHRUB BIRCH	L-SB	1.67	1	3	6
SHRUB BIRCH	L-WA	3.33	2	4	3
SPRUCE	L-SB	2.91	1	5	16
SPRUCE	L-WA	4.47	2	8	15
SPRUCE	M-SPW	3.83	2	7	15
SPRUCE	M-SW	4.83	2.5	8	15
SPRUCE	D-WPS	3.67	2	7	15
SPRUCE	D-WS	4.80	3	7	15
BALSAM POPLAR	L-WA	5.03	3	8	15
BALSAM POPLAR	M-SPW	6.87	4	11	15
BALSAM POPLAR	M-SW	6.33	3.5	9	15
BALSAM POPLAR	D-WS	6.00	2	9	15
WILLOW	L-SB	4.20	2	8	15
WILLOW	L-WA	7.17	4	15	15
WILLOW	M-SPW	6.33	3.5	10	15
WILLOW	M-SW	5.00	2	8.5	18
WILLOW	D-WPS	7.82	5.5	13	17
WILLOW	D-WS	8.76	3	17	17

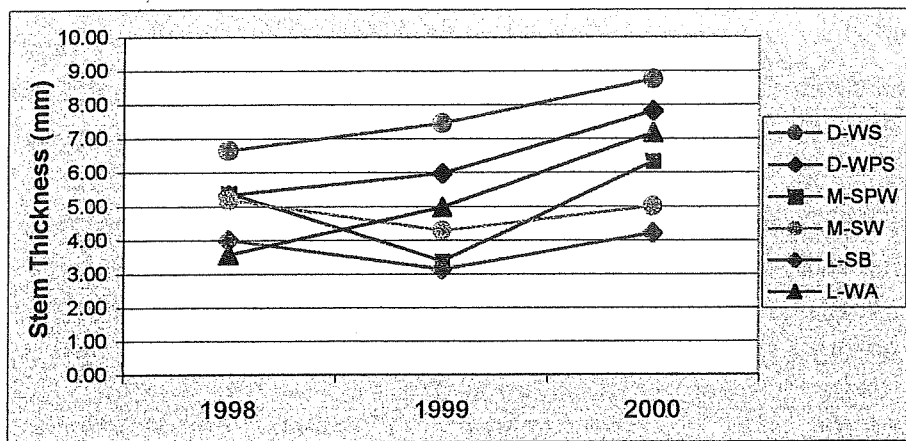


Fig. 11. Average diameter of willows browsed by snowshoe hares in 6 vegetation zones, snowshoe hare surveys 1998 - 2000. The annual survey is conducted near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve. Codes for vegetation

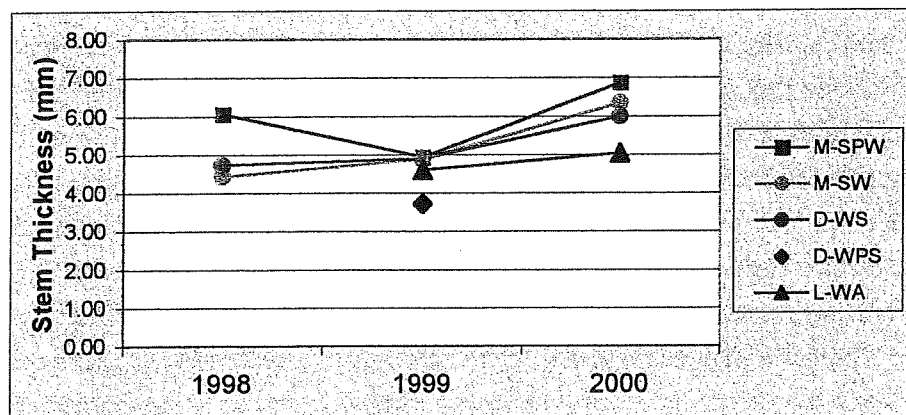


Fig. 12. Average diameter of poplars browsed by snowshoe hares in 5 vegetation zones, snowshoe hare surveys 1998 - 2000. The annual survey is conducted near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve. Codes for vegetati

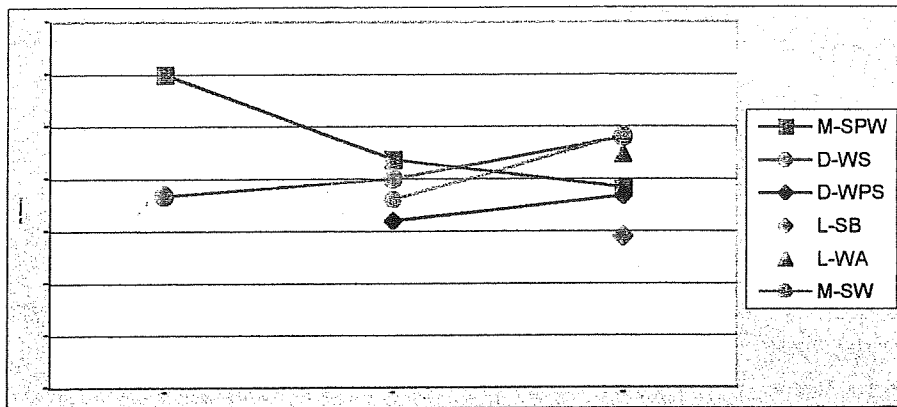


Fig. 13. Average diameter of spruce browsed by snowshoe hares in 6 vegetation zones, snowshoe hare surveys 1998 - 2000. The annual survey is conducted near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve. Codes for vegetation

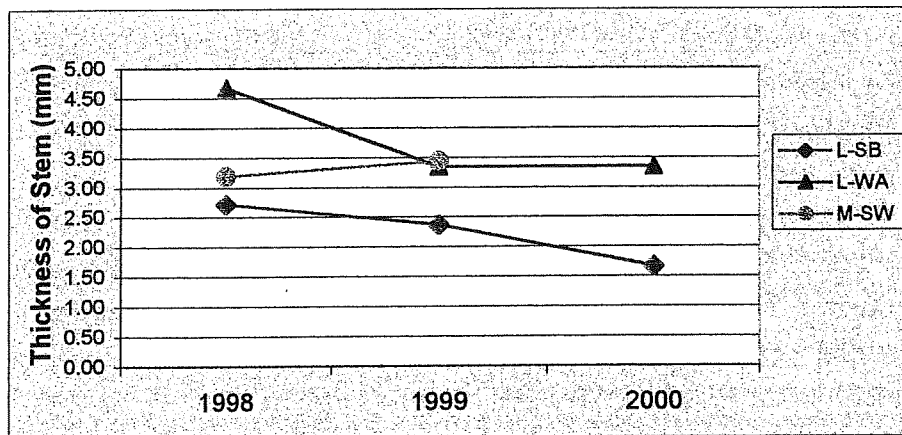


Fig. 14. Average diameter of shrub birch browsed by snowshoe hares in 3 vegetation zones, snowshoe hare surveys 1998 - 2000. Shrub birch were buried under snow in M-SW in 2000. The annual survey is conducted near Wiseman, Alaska, in eastern Gates of th

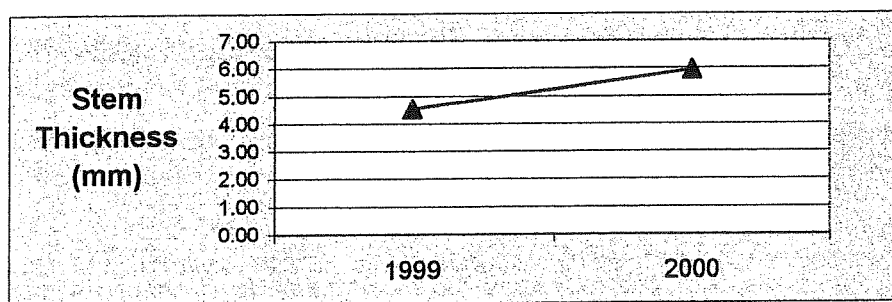


Fig. 15. Average diameter of alder browsed in a lightly vegetated area dominated by willow and alder shrubs by snowshoe hares, snowshoe hare surveys 1998 - 2000. The annual survey is conducted near Wiseman, Alaska, in eastern Gates of the Arctic Nationa

and 3.3mm in L-WA, with stem thickness ranging from 1-4mm. These figures average 1mm or more smaller than what was measured in 1998 (Fig. 14).

**Alder**— In L-WA, hares browsed Alnus sp. stems 2-10mm thick, with an average dpb of 5.9mm. Although the range of browsed stem thickness was the same as the range measured in 1999, the average dpb was 1.4mm thicker in 2000 (Fig. 15).

*Degree of Browsing:*

**L-SB**—Spruce trees dominate this VCC, most of which are older trees not browsed by hares. The 3 spruce that were clipped and completely girdled were small saplings which had been browsed in previous years and had since died. Hares had browsed 83.3% of the willows, at least in some degree. Shrub birch had been mostly buried under snow, and much of what was above snowline had already been browsed in previous years. Hares had clipped the single poplar found in this VCC also (Fig. 16).

**L-WA**—This VCC is a relatively open, sparsely vegetated area. The spruce in this area are mostly young trees and saplings, and this is reflected in the degree to which hares had browsed the stems and branches. Roughly two-thirds of the spruce were browsed by hares, over half of these at least partially girdled. Even a greater proportion of poplars, willows and alders found in this VCC were browsed by hares. Every poplar seen in L-WA had been browsed by hares in some degree. Few shrub birch were above snowline, but of those found, over half had been clipped by hares (Fig. 17).

**M-SW**—Much of the vegetation in this VCC was buried under snow. All of the willows tallied had been browsed by hares, over half of them both clipped and girdled at least partially. All but 1 poplar had been browsed by hares, with about half of them completely girdled. Of the spruce, over half were not browsed by hares, but some clipping and girdling was noted on 32 trees (Fig. 18).

**M-SPW**—Again, willow and poplar were heavily browsed by hares. Of the 107 willow stems tallied, only 3 had not been browsed by hares. Forty-five (42%) had been clipped and completely girdled. Poplars exhibited a similar amount of browsed stems, with 43 of the 100 stems tallied completely girdled and only 11 stems not browsed by hares. Spruce were also fairly heavily browsed in this VCC, with only 1 of the 66 stems tallied not browsed by hares. Most browsing of spruce was only clipping of twigs, although 13 small trees had been completely girdled as well (Fig. 19).

**D-WS**—In this densely vegetated area, 51 of 100 willow stems had been completely girdled. Only 6 of the willow stems tallied had not been browsed by hares. Most unbrowsed willow stems were dead, and many stems that had been girdled in previous years were also dead. Although poplars do not comprise a large percentage of the vegetative cover in this VCC, of those present, most also had been browsed by hares, with over half having been at least

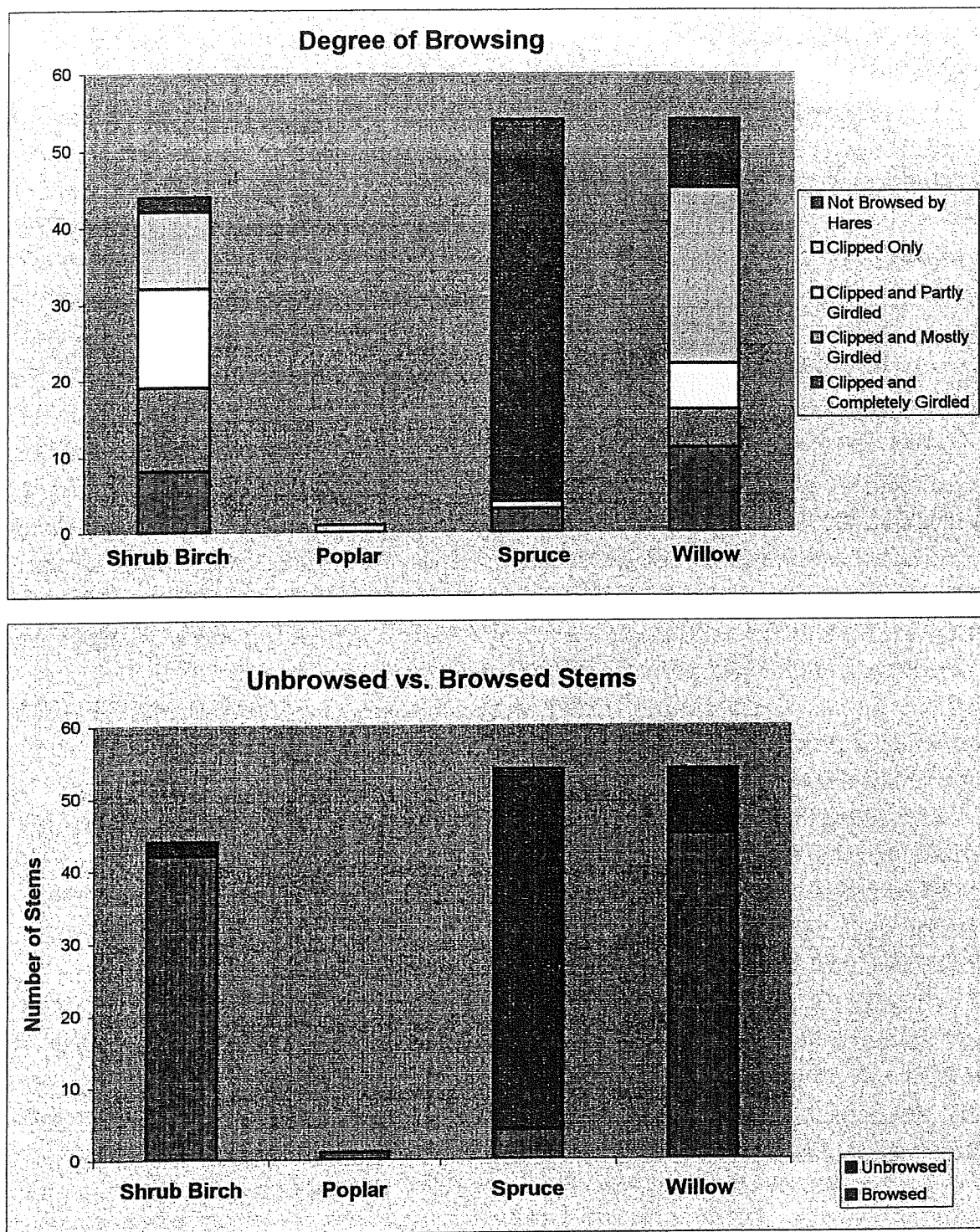


Fig. 16. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in L-SB (lightly vegetated) transects dominated by spruce and shrub birch. Data from the 4 browsed categories in the top graph were combined to form the single "browsed" category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

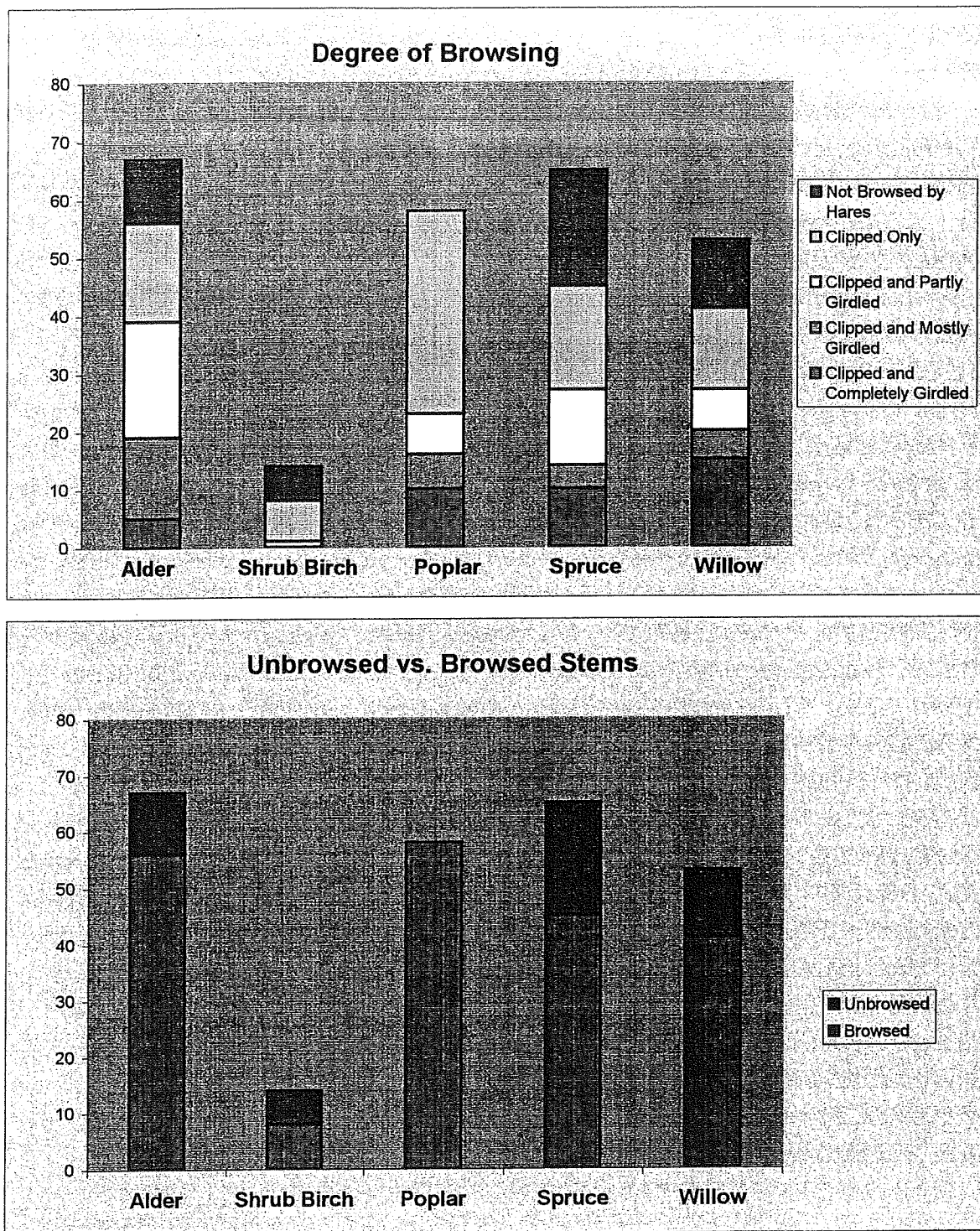


Fig. 17. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in L-WA (lightly vegetated transect dominated by willow and alder). Data from the 4 browsed categories shown in the top graph were combined to form the single "browsed" category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

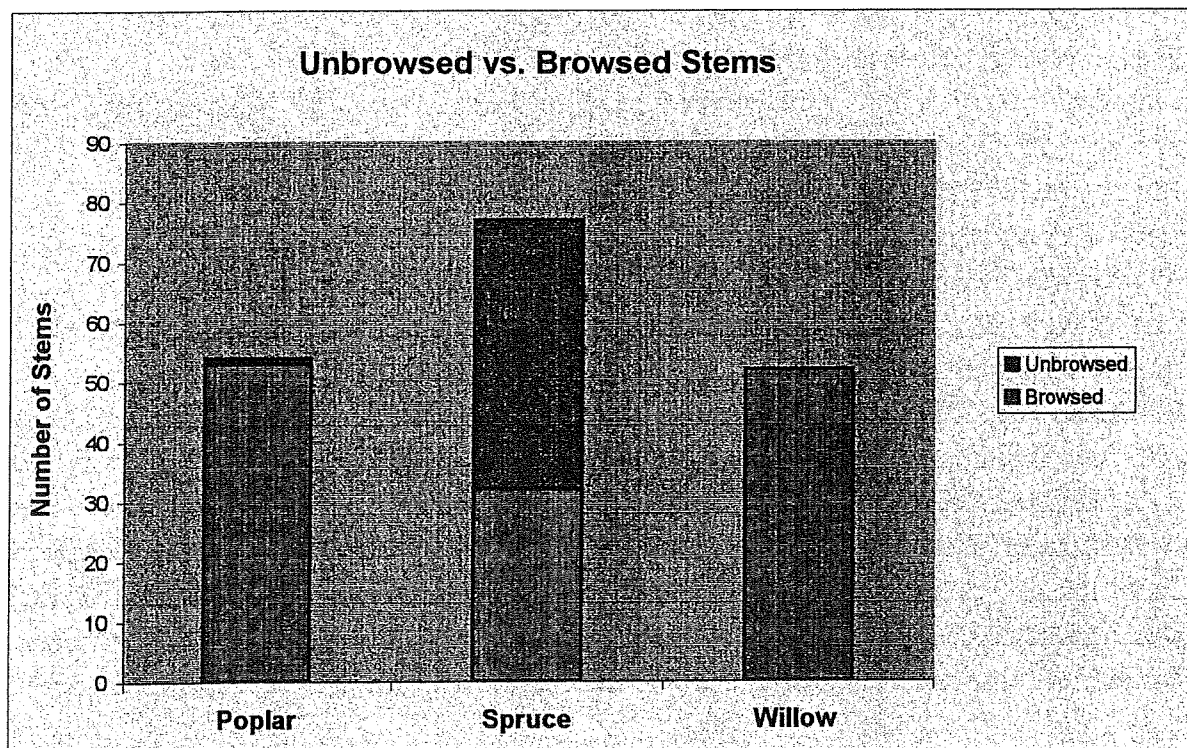
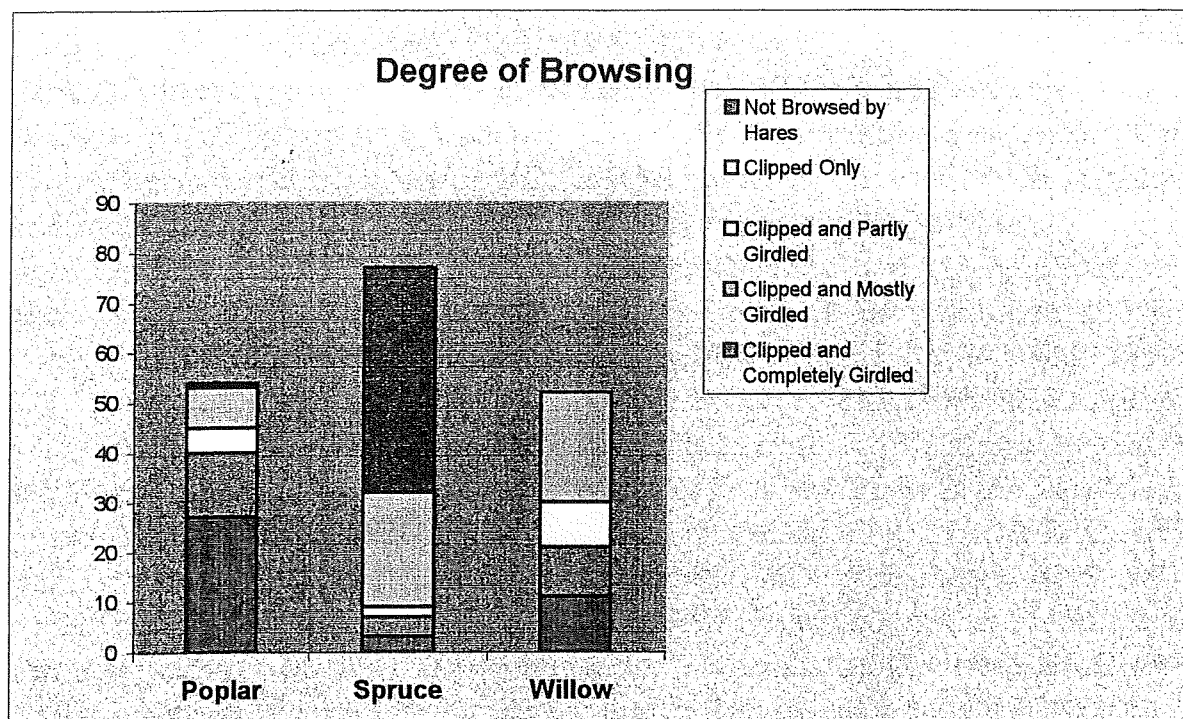


Fig. 18. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in M-SW (moderately vegetated transects dominated by spruce and willow). Data from the 4 browsed categories in the top graph were combined to form the single "browsed" category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

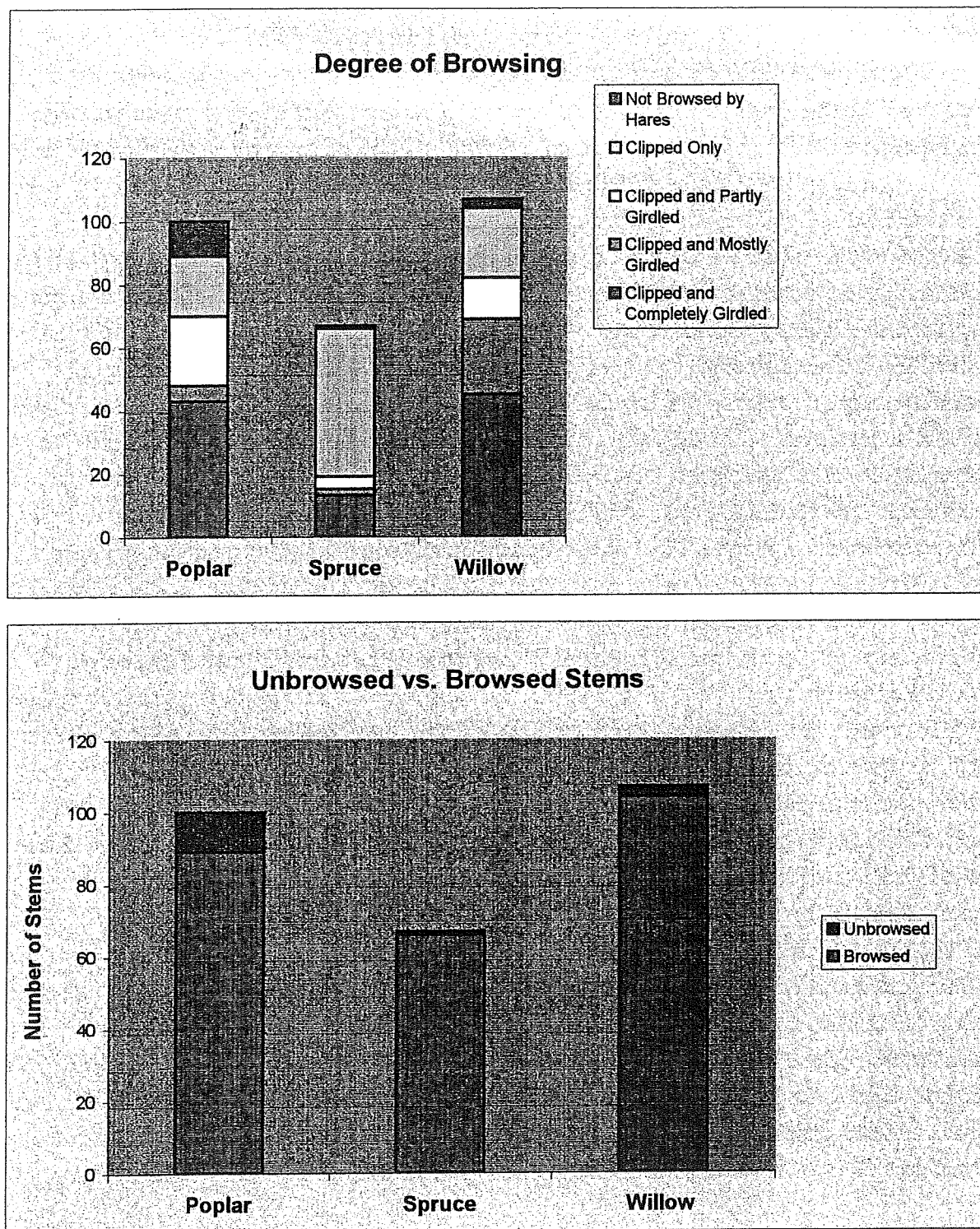


Fig. 19. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in M-SPW (moderately vegetated transects dominated by spruce, balsam poplar and willow. Data from the 4 browsed categories in the top graph were combined to form the single "browsed" category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

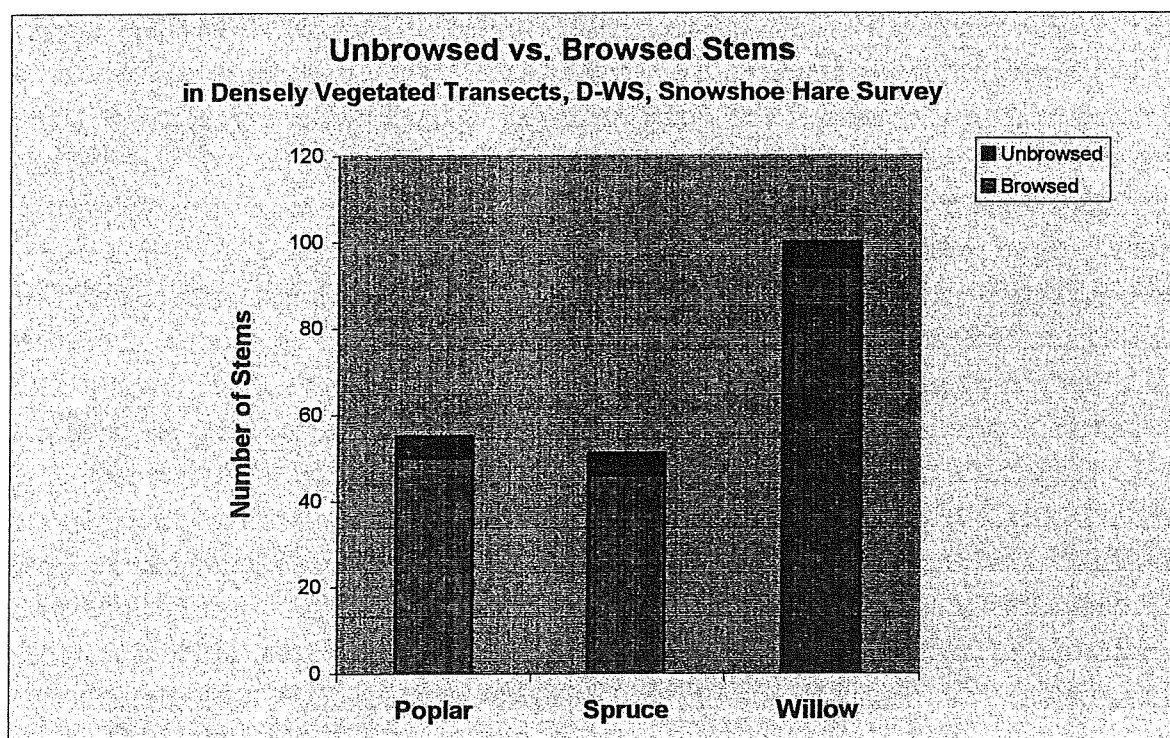
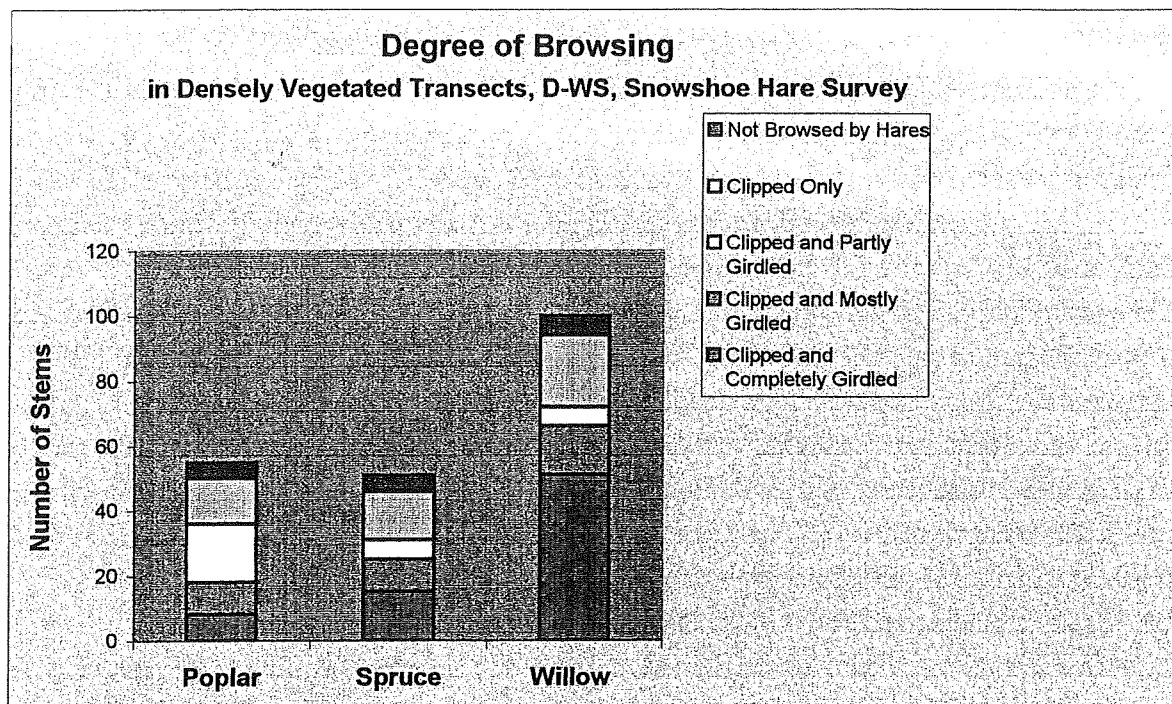


Fig. 20. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in D-WS (densely vegetated transects dominated by willow and spruce). Data from the 4 browsed categories in the top graph were combined to form the single "browsed" category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

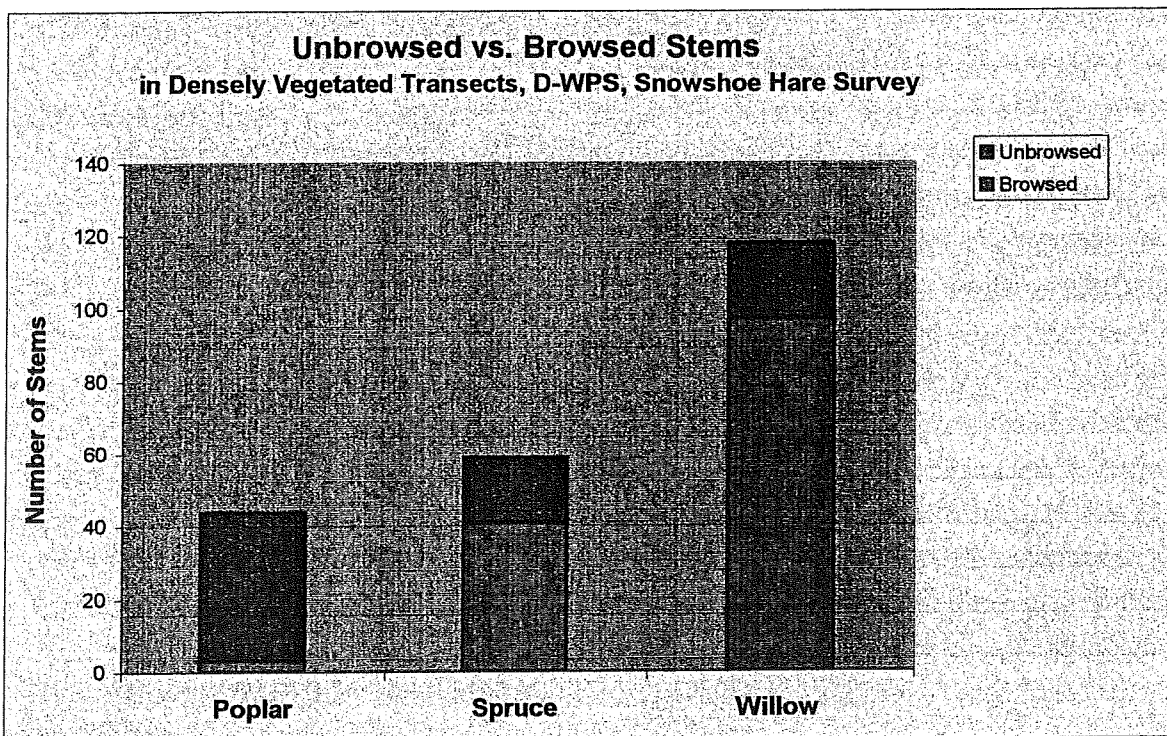
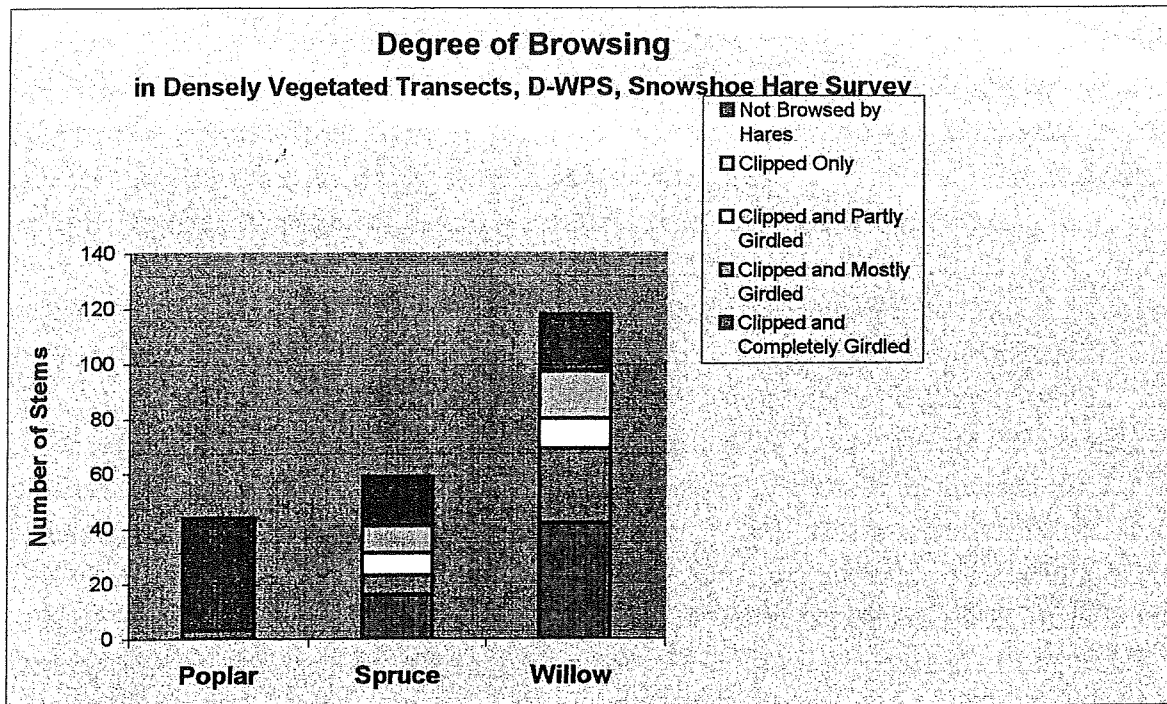


Fig. 21. Degree of browsing (top) and browsed vs. unbrowsed stems (bottom) in D-WPS (densely vegetated transects dominated by willow, balsam poplar and spruce). Data from the 4 browsed categories in the top graph were combined to form the single "browsed category in the bottom graph. Height of bars reflects the number of stems counted in the area for that particular species. Snowshoe hare survey, Gates of the Arctic National Park and Preserve, Alaska, March 2000.

partially girdled. Of the 50 spruce trees tallied, 45 had been browsed by hares, 15 of these completely girdled (Fig. 20).

**D-WPS**—Willows in this area were browsed heavily by hares, with most unbrowsed stems being those of old, thick trunks or dead shrubs. Over half of the willow stems tallied had been at least mostly girdled, if not completely so. The poplars in this area are mostly large trees, with thickly barked trunks. The 3 poplars that were completely girdled were trees that had fallen over the creek bank where the hares could reach them in the winter by reaching up from the snow or crawling out on top of them. Most of the spruce trees in this area had been browsed by hares, over half of those tallied having been at least partially girdled (Fig. 21).

#### Soil Samples

Two soil samples were collected this year from exposed soil banks that hares were *not* visiting. The samples underwent the same treatment as the soils previously collected, being tested for calcium, potassium, magnesium, sodium and chloride. These soils did not contain as large a proportion of calcium as the soils from licks visited by hares collected in 1998 and 1999 (Fig. 22). Roughly the same concentrations of sodium, potassium and chloride were found in the unvisited soils as in the visited soils and the average concentration of magnesium also was not significantly different (Fig. 22, Appendix IV). When compared to just the soils collected in 1998, however, none of the concentrations of minerals is significantly different. Conversely, when compared to just the soils collected from 1999, the 1999 soils have greater concentrations of calcium and magnesium than the unvisited soils. These conflicting results may be due to improper or inconsistent collection of soils or testing for irrelevant mineral(s). These results are discussed further below.

#### DISCUSSION

The 2000 snowshoe hare survey marked the third year of hare abundance within the study area. We saw many hares every day, frequently observing several hares at the same time. However, our track counts did not reflect a high hare population. Without fresh snow, compaction of the old snow caused the surface to become very hard; the lightweight hares left no perceptible tracks. The low number of tracks counted while seeing evidence of high numbers of hares—including more sightings of hares than in past years and an increased level of browsing by hares on nearly everything above snowline—prompted us to devise a method of collecting additional browse data. Overbrowsing from hares had killed several small spruce seedlings and saplings, and it appeared that more young spruce would die from overbrowsing this year also. Many of the poplars in this area display stunted growth due to repeated heavy browsing. We also noted that nearly all willow, poplar and spruce with a girth  $\leq 5$  cm diameter at snow level had been browsed

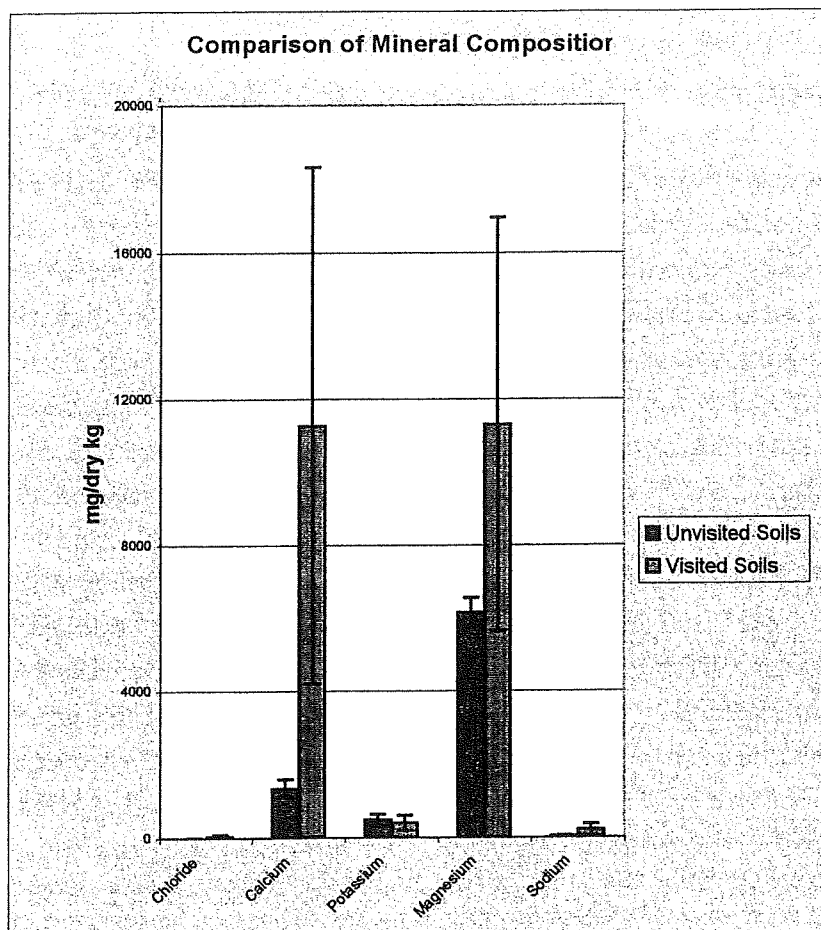


Fig. 22. Comparison of mineral concentrations in 5 soil samples collected from 9 sites visited by snowshoe hares and 2 sites unvisited by snowshoe hares near Wiseman, Alaska, eastern Gates of the Arctic National Park and Preserve.

and girdled by hares from snowline to about 3 feet above the snow. Hares had girdled even some of the lower branches of large spruce trees. Much that was left untouched were the larger trees with thick bark or stems that were already dead. Considering the difficulties of the past few years in counting tracks (mainly due to unfavorable snow conditions), monitoring the level of browsing by hares may be a better way to index the snowshoe hare population in this area, particularly in high hare years. Another option would be to wait until favorable snow conditions exist and conduct the survey immediately afterward. This approach, however, would be impractical due to the remoteness of the study area to my residence. March is generally the best month to conduct the survey since February has little daylight and is usually very cold, while April is usually too warm and melting snow becomes a problem.

The simple analyses performed on soils consumed by hares have added a whole new dimension to this study and raised more questions regarding the interactions between the snowshoe hares, what they eat, and lynx. Why do hares consume particular soils? Do they seek a particular mineral? Does eating soil have an effect on the hares' ability to counteract plant toxins? Wiseman trapper Jack Reakoff noted (pers. commun.) that the lynx were "skinny" despite the abundance of snowshoe hare, their primary prey. Is the hare diet somehow affecting lynx? Dr. Perry Barboza (nutritional biologist, University of Alaska Fairbanks, pers. commun.) stated that the toxic secondary compounds in plants that the hares are ingesting would be processed and excreted; they would not be transmitted to the lynx. Also, although the soils may have high concentrations of calcium and magnesium, they may still be seeking sodium. But if hares are after sodium, why did they not consume the soils on Marion Creek, which contained approximately the same concentrations of sodium as the other soils tested? While hare densities appeared fairly high in the Marion Creek area, there were no hare tracks going to the exposed (and easily accessible) soil banks where we collected the soils. Conversely, Reakoff (pers. commun.) had noted "highways" of hare trails going directly to the soil licks we tested in 1999.

Since the soils were analyzed for only 5 minerals, there could be many things we are missing in our soil analyses, among them, the presence of heavy metals. Should the hares be ingesting heavy metals, either through the soil or plants, or organochlorides (toxic compounds found in plants) these could be transmitted to lynx (Todd O'Hara, toxicologist, North Slope Borough Dept. of Wildlife, pers. commun.). The most conclusive way to determine whether or not hares are consuming heavy metals or organochlorides and that these are being transmitted to lynx would be to analyze tissue samples from hares and lynx. This sort of investigation would be taking the snowshoe hare study beyond its simple objective of determining indices for the hare population. However, determining if these substances are in the body tissues of hares and lynx may carry broader implications in that other animals, such as moose and sheep, which are harvested for human consumption, may also have levels of heavy metals in their tissues as well.

## RECOMMENDATIONS TO MANAGEMENT

1. Continue the snowshoe hare survey until the population has completed a full "cycle" and is again recovering from low levels (this may be another 3-5 years).
2. Further investigate the issue of a possible connection between hare diet and health and lynx health. Todd O'Hara, toxicologist for the Department of Wildlife in the North Slope Borough has expressed an interest in this particular aspect of the study and has said he'd be willing to help determine which parameters to analyze and lead the investigation. A Memorandum of Understanding would need to be signed to specify the details and formalize this agreement.

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Appendix I. Deposition of tracks and trails on 100m transects from the 2000 snowshoe hare track count survey near Wiseman, Gates of the Arctic National Park and Preserve, Alaska. In vegetation cover and composition (VCC) types, the letters stand for the following: D=dense vegetation, M=moderate vegetation, L=light vegetation, W=willows, P=poplars, S=spruce, B=shrub birch, A=alder.

VCC	3/12/2000 trails	3/13/2000	3/14/2000 trails	3/15/2000	3/16/2000	3/17/2000
L-SB-1	0	1	0	1	0	0
L-SB-2	0	0	0	0	0	0
L-WA-1	21	1	2	0	3	1
L-WA-2	27	2	0	0	0	0
M-SW	3	16	11	14	6	10
M-SPW-1	20	17	18	14	16	24
M-SPW-2	21	15	25	18	28	25
M-SPW-3	37	22	33	14	27	14
D-WS-1	53	33	36	14	1	25
D-WS-2	30	28	23	16	6	28
D-WPS	24	16	26	14	25	26

Bad data due to improper brushing (on the 12th) and observer failure (on the 16th)—not included in calculations

Appendix II. Retention of tracks and trails on 100m transects from the 2000 snowshoe hare track count survey near Wiseman, Gates of the Arctic National Park and Preserve, Alaska. Track retention was counted in two 3-day sessions. In vegetation cover and composition (VCC) types, the letters stand for the following: D=dense vegetation, M=moderate vegetation, L=light vegetation, W=willows, P=poplars, S=spruce, B=shrub birch, A=alder.

VCC	3/12/2000 trails	3/13/2000 trails	3/14/2000 trails	3/15/2000	3/16/2000 trails	3/17/2000 trails
L-SB-1	0	4	4	0	0	0
L-SB-2	6	8	9	0	0	1
L-WA-1	25	24	22	0	0	2
L-WA-2	21	27	23	0	0	0
M-SW	3	23	19	11	31	9
M-SPW-1	13	26	35	9	23	7
M-SPW-2	6	19	37	14	24	6
M-SPW-3	27	42	54	25	27	10
D-WS-1	27	45	54	10	10	4
D-WS-2	22	33	37	17	19	8
D-WPS	12	25	40	9	19	17
						4

Appendix III. Weather data from the 2000 snowshoe hare track count, conducted March 12 - 17, near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve.

DATE	TIME		TEMP (F)		WIND		SKY		PRECIP
	Start	Finish	Start	Finish	Start	Finish	Start	Finish	
3/12/2000	11:57	15:56	12	30	calm	calm	thin clouds	thin clouds	0
3/13/2000	11:30	14:40	7	24	slight breeze	calm	clear	clear	0
3/14/2000	11:19	15:04	27	32	slight windy	breeze	clear	clear	0
3/15/2000	11:28	15:14	27	29	calm	calm	thin clouds	clear	0
3/16/2000	11:19	14:34	31	32	slight breeze	calm	high overcast	thin clouds	0
3/17/2000	11:23	14:25	17	23	calm	calm	thin clouds	thin clouds	0

Appendix IX. Concentrations of 5 minerals in soils available to but unvisited by snowshoe hares near Wiseman, Alaska, snowshoe hare survey, eastern Gates of the Arctic National Park and Preserve, March 2000.

Location	(mg/dry kg)				
	Chloride	Calcium	Potassium	Magnesium	Sodium
Marion Creek #1	4	1470	567	5940	41.6
Marion Creek #2	5.2	1210	397	6340	30.8